INDOOR AIR QUALITY REASSESSMENT

Squannacook Elementary School
North Middlesex Regional School District
66 Brookline Road
Townsend, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of James W. McCormick, Superintendent of Schools, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) conducted a reassessment of the indoor air quality at the Squannacook Elementary School in Townsend, MA. The school was originally visited on December 8, 1999, by Cory Holmes, Environmental Analyst, Emergency Response/Indoor Air Quality (ER/IAQ), BEHA. A report was issued (MDPH, 2000) which described the conditions of the building at that time. The report showed that there were problems identified and gave recommendations on how to correct those problems. On October 19, 2000, a visit was made to this school by Michael Feeney, Chief of BEHA's ER/IAQ Program to conduct a follow-up indoor air quality assessment.

The school is a two-story, steel and cement block structure constructed in 1989 and houses 3rd through 5th grade students. The second floor is largely comprised of general classrooms. The first floor consists of general classrooms, library, cafeteria, computer room and office space.

Actions on Recommendations

BEHA previously made 15 recommendations **(in bold)** to improve indoor air quality at the school (MDPH, 2000). School officials reported that they have acted on all of these recommendations that are in control of school department personnel. The following is a status report of action(s) on BEHA recommendations based on reports from school officials, documents, photographs and BEHA staff observations.

1. **Survey classrooms for univent function to ascertain if an adequate air supply exists for each room and make univent repairs as needed. Check fresh air intakes for repair and increase the percentage of fresh air intake if necessary.**

   Carbon dioxide testing by BEHA staff was conducted in the school, which found all but three areas within the building below 800 ppm, which is the BEHA recommended comfort guideline. Fresh air intakes were examined and adjusted (ATCS, 2000). These readings indicate that the ventilation system was both repaired and adjusted.

2. **Determine origin of "buzzing" noise from univent in classroom 104, make repairs as needed.**

   The univent in this classroom was repaired, eliminating the buzzing noise.

3. **Inspect exhaust motors and belts periodically for proper function, repair and replace as necessary.**

   Parts for exhaust vents were reportedly purchased and installed (MCH, 2000). All exhaust vents were operating during this assessment. Carbon dioxide levels measured during the assessment indicates that the exhaust ventilation system was adequately operating.

4. **Repair/reactivate exhaust vent in classroom 114 restroom.**

   This restroom exhaust vent was drawing air, indicating this vent was repaired and reactivated.

5. **Remove all blockages from univent fresh air diffusers and return vents to facilitate airflow.**

Teachers were instructed by school department officials to keep both supply and exhaust vents clear of obstruction. BEHA staff noted that vents were clear of obstructions.

6. **Operate univents and exhaust ventilation while classrooms are occupied. Consider having the systems balanced by a professional HVAC engineer.**
   Both univents and exhaust vents were operational during this reassessment. Reduced carbon dioxide levels measured during the reassessment indicate that the ventilation system is now balanced.

7. **For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. Avoid the use of feather dusters, to control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all non-porous surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).**
   HEPA filter vacuum cleaners were acquired (see Picture 1).

8. **Repair any water leaks and replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.**
   An area of minor ceiling plaster staining was noted in classroom 202, however the roof above this water stain was repaired. Roof repairs are reportedly ongoing; no other signs of water damage in ceiling plaster or wallboard were noted during this assessment.

9. **Move plants away from univents and ensure drip pans are placed underneath plants in classrooms. Examine plants in classrooms for mold growth in water catch basins. Disinfect water catch basins if necessary. Ensure drip pans are placed underneath plants in classrooms. Consider discontinuing the use of window planters as well as hanging plants above carpeting in classrooms.**

   Plants were observed to have been removed from univents.

10. **Acquire current Material Safety Data Sheets for all products that are used in the building that contain hazardous materials, including office supplies, in conformance with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).**

    MSDS for maintenance materials used in the building are located in a three-ring notebook and placed in a special MSDS information station (see Picture 2).

11. **Store chemicals and cleaning products properly and out of the reach of students.**

    Cleaning products were not observed in sink areas.

12. **Change filters for ceiling-mounted air conditioners as per the manufacturer's instructions to prevent the re-aerosolization of dirt, dust and particulate matter.**

    Filters are reportedly being maintained in accordance with air conditioner manufacturer's recommendations.

13. **Transfer sand stored beneath sink in classroom 106 into alternate container.**

    Sand formerly in a container with a hazardous material placard was observed to have been placed in another container.

14. **Keep wasp nests away from univents to prevent the aerosolization of potentially allergenic materials.**

    Wasp nests were not observed in classrooms identified as having them during the initial assessment.

15. **Clean chalkboards and chalk trays regularly to prevent the build-up of excessive chalk dust.**

    Chalkboards were found to be free of accumulated dust.

16. **Re-caulk spaces around the sink countertop and splashboard in classroom 112**.

    Spaces around the sink countertop and splashboard in classroom 112 were re-caulked.

Beyond the recommendations made in the initial report, the school department hired a private firm, Boston Filter Company, to change univent filters four times a year (BFC, 2000), which should help reduce the amounts of airborne particulate within the building.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551.

Results

This school has a student population of 488 and a staff of approximately 60. The tests were taken during normal operations. Test results appear in Tables 1-4.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 (parts per million of air) ppm in three of thirty-five areas surveyed, which indicates adequate ventilation in most areas of the school. The three areas over 800 ppm of carbon dioxide levels were below 900 ppm, which would indicate minor adjustment of the univents in these areas may be needed.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself at levels measured in this building. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings at the school were in a range of 70^{o} F to 74^{o} F, which were within the BEHA comfort range. The BEHA recommends that indoor air temperatures be maintained in a range of 70^{o} F and 78^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with adequate fresh air supply.

The relative humidity in the building ranged from 31 to 39 percent, which was below the BEHA recommended comfort range in all areas sampled, but also indicates no unusual source of moisture within the building. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the

building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

As noted in the previous report, contractors involved in the installation of the roof are in litigation with the North Middlesex School District. At issue are several conditions that were not accounted for during the installation of a roof over the building (see Picture 3). The peaked roof does not appear to have either ridge vents (see Pictures 4) or soffit vents (see Picture 5) to aid in air circulation within the roof space. Of note is the absence of a gutter/downspout system to direct rainwater from the base of the exterior walls. After rainstorms, the exterior walls are saturated with moisture (see Picture 6 and 6A). Rainwater runs off the roof onto the ground at the base of the building. This runoff has created a trench parallel to the base of the wall, which allows rainwater and melting snow to pool against the foundation and the exterior wall of this wing. Splashing water along the edge of the building wets the base of exterior walls (see Picture 7). Growth of moss on exterior brickwork is another indication of chronic moisture exposure from rainwater in this building system. Moss growth also holds moisture against brickwork. North facing corners and walls of this building are particularly vulnerable to moisture for extended periods of time, since this brick is not dried out by exposure to direct sunlight (see Picture 8). Excessive exposure to water of exterior brickwork can result in damage over time. During winter weather, the freezing and thawing of moisture in bricks can accelerate the deterioration of brickwork.

Lack of roof water drainage also results in excessive moisture exposure to the wood of the fascia (see Figure 1). Spaces in the fascia (see Picture 5) immediately underneath shingles at the edge of the roof appeared to be blackened in some areas, which could indicate both excess water exposure and mold growth.

Conclusions/Recommendations

The staff of the Squannacook Elementary School appears to have acted on all of the recommendations made in the previous BEHA indoor air quality report. The school is a well-maintained building that appears to be free of most indoor air quality related problems that are commonly found by BEHA staff in other public schools. Beyond the problems noted in the original report, the school district has also taken measures to repair roofing problems experienced in this building. To that end, the following recommendations are made to prevent possible damage to exterior brickwork.

1. Consider installing a gutter/downspout system on the edge of the peaked roofs of the building to direct water away from the base of the building. The installation of a drainage system may also be necessary to direct water away from the foundation.
2. Replace water damaged fascia material. The edge of the roof shingles should be repaired in a manner to limit water contact with fascia materials (see Figure 1).

References

ATCS. 2000. Squannacook Elementary Report. Accurate Temperature Control Service, Wilton, NH.

BFC. 2000. Filter Change Invoice Requisition No. 00011590. Boston Filter Company, Orange, MA.

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials & Code Administrators International, Inc., Country Club Hills, IL.

MCH. 2000. Squannacook School Parts Invoice. Minuteman Cooling & Heating, Athol, MA.

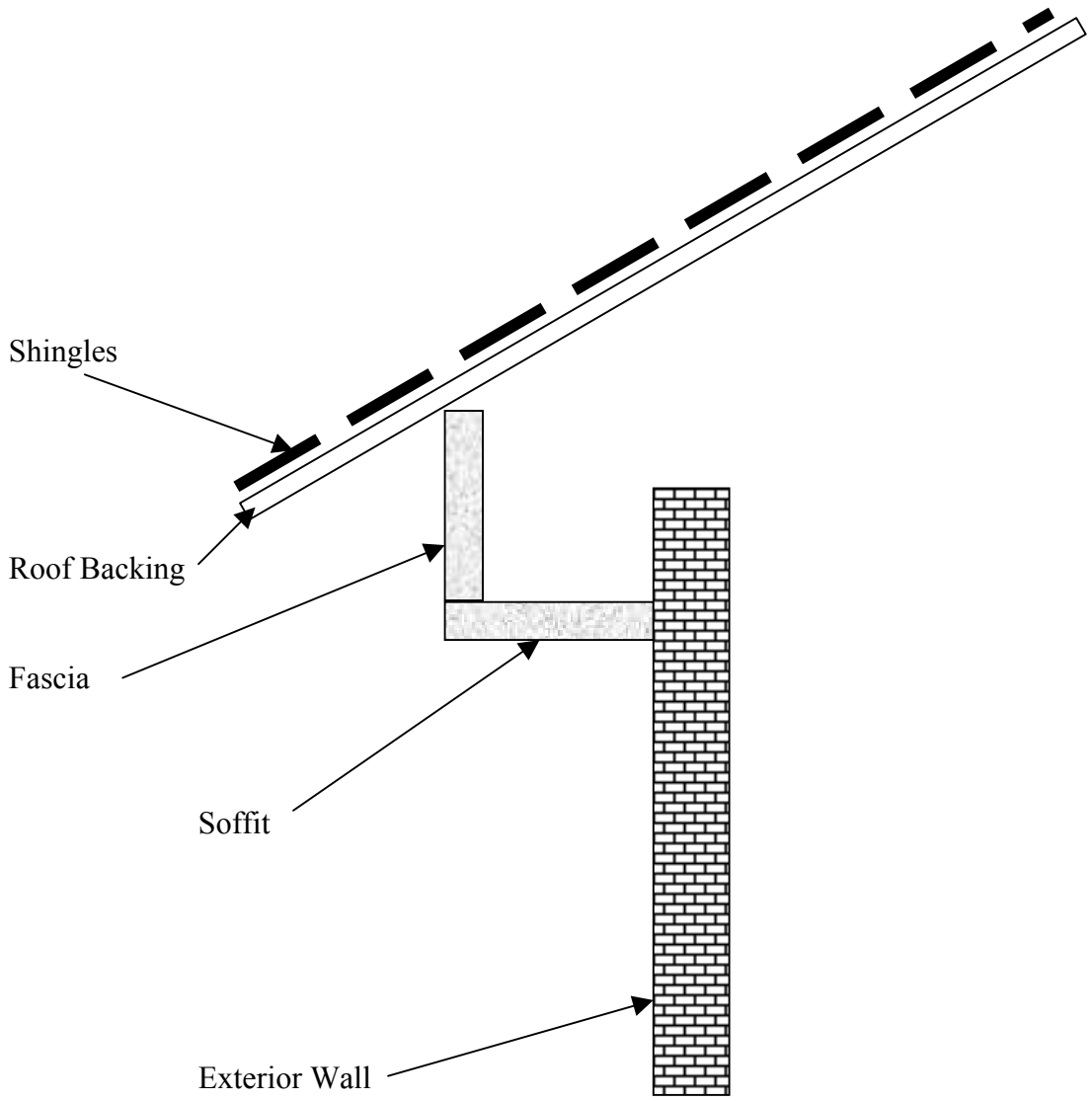
MDPH. 2000. Indoor Air Quality Assessment Squannacook Elementary School, Townsend, MA. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA.

MGL. 1983. Hazardous Substances Disclosure by Employers. Massachusetts General Laws. M.G.L. c. 111F.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Figure 1 **Components of the Roof/Exterior Wall Structure**



Picture 1

HEPA Filter Vacuum Cleaners

Picture 2

MSDS Storage Rack and Binder

Picture 3

Roof of School

Picture 4

View From Within Roof; Note no View of Exterior Light in Corners or in the Peak of Roof, Which Indicates no Ridge Vent

Picture 5

View From Ground of Soffit; Note no Soffit Vents and Deterioration of Wood at Joint

Picture 6

Moistened Brickwork, Photo Taken at 10:15 AM

Picture 6A

Moistened Brickwork Depicted in Picture 5, Photo Taken at 2:10 PM, Note that Brick Has Not Dried Out After Four Hours

Picture 7

**Moistened Brickwork at Base of Rear Wall from Splashing Rainwater,
Note Furrow in Ground at Base of Wall Which is Created by Rainwater Running Off Roof**

Picture 8

Moistened Brick Not in Direct Sunlight

TABLE 1

Indoor Air Test Results – Squannacook Elementary School, Townsend, MA – October 19, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	406	60	44					
Room 212	610	71	35	6	No	Yes	Yes	
Room 212C	641	72	35	6	Yes	Yes	Yes	
Room 212B	626	72	33	0	Yes	Yes	Yes	Window and door open, ceiling fan-on
Room 212	617	72	34	5	No	Yes	Yes	
Room 210	677	72	34	26	Yes	Yes	Yes	Window open
Room 209 (Art Room)	808	73	36	24	Yes	Yes	Yes	Door open
Teachers' Workroom	532	70	34	1	Yes	Yes	Yes	Window and door open, photocopier, laminator
Room 201	575	71	35	0	Yes	Yes	Yes	Door open
Room 202	793	72	35	25	Yes	Yes	Yes	Water stains-ceiling wallboard, door open
Room 203	767	73	33	20	Yes	Yes	Yes	Window and door open

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results – Squannacook Elementary School, Townsend, MA – October 19, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 205	811	72	33	22	Yes	Yes	Yes	Door open
Room 204	751	72	32	21	Yes	Yes	Yes	Window open
Room 207	557	70	31	19	Yes	Yes	Yes	Window open
Room 206	587	70	34	1	Yes	Yes	Yes	
Room 208	689	70	35	20	Yes	Yes	Yes	
Music Room	517	70	34	24	Yes	Yes	Yes	Exhaust in closet, door open
Room 107	541	70	34	0	Yes	Yes	Yes	Door open
Room 105	611	71	35	0	Yes	Yes	Yes	Door open
Library	620	72	34	8	Yes	Yes	Yes	Door open
Room 109	580	73	36	7	Yes	Yes	Yes	Cooking
Room 115	739	71	39	25	Yes	Yes	Yes	Door open

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Squannacook Elementary School, Townsend, MA – October 19, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 114	855	73	37	19	Yes	Yes	Yes	Restroom fan on, door open
Room 113	645	72	37	26	Yes	Yes	Yes	Window open
Room 112	548	71	36	0	Yes	Yes	Yes	Sink re-caulked, door open
Room 110	741	73	38	30	Yes	Yes	Yes	Plants, hospicide disinfectant, door open
Room 111	779	72	38	22	Yes	Yes	Yes	Bird/mouse/fish
Nurse's Office	704	72	38	3	Yes	Yes	Yes	Door open
Cafeteria	629	71	36	60+	Yes	Yes	Yes	
Room 106	556	71	35	24	Yes	Yes	Yes	No chemicals-chlorine container
Room 104	558	71	33	23	Yes	Yes	Yes	Window and door open
Room 103	699	72	37	22	Yes	Yes	Yes	Door open
Room 102	786	73	37	25	Yes	Yes	Yes	Door open

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Squannacook Elementary School, Townsend, MA – October 19, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Computer Room	734	74	33	21	Yes	Yes	Yes	27 computers, 2 a/c-filters washed
Room 101	682	72	32	21	Yes	Yes	Yes	Window open
Main Office	639	72	33	1	Yes	Yes	Yes	

*** ppm = parts per million parts of air**
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%